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### Precursor Shocks produced by a Large-yield Chemical Explosion

PRECURSOR shocks are phenomena normally associated with surface burst or low-level nuclear explosions. The precursor moves out along the ground ahead of the primary shock, and usually produces a large amount of airborne dust. The precursor has been explained<sup>1</sup> as an effect of the intense thermal radiation produced by a nuclear explosion.

In July 1964, a 500 ton TNT hemispherical surface burst charge was detonated at Suffield Experimental Station in Alberta, Canada. High-speed photographs of the explosion show that in some radial directions dust clouds moved out ahead of the main shock and had reached a height of 50 ft. before its arrival. The dust clouds were enveloped by a shock wave. At ground-level this precursor eventually became downward facing and produced a reflected shock and a Mach stem. Photography from an aeroplane at 12,000 ft. immediately above the explosion showed that all the precursors were produced along well-compacted roadways running radially from the charge centre. The precursors occurred in the region 250-750 ft. from the centre of the explosion, corresponding to peak overpressure levels of 150 lb./in.<sup>2</sup>-20 lb./in.<sup>2</sup>. A gauge measuring the total density within the blast wave, by means of a  $\beta$ -radiation absorption technique<sup>2</sup>, showed the dust density to be four times that of the peak air density expected in the blast wave at that position. Targets placed in the regions of the precursors experienced considerably more damage than had been expected. From the evidence of seismometer records it seems probable that the precursors were produced by strong ground waves feeding energy into the air ahead of the air shock in a manner similar to that observed by Boys<sup>3</sup> for supersonic missiles penetrating metal plates and by Benioff, Ewing and Press<sup>4</sup> for earthquakes.

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<sup>1</sup> Dewey, J. M., and Anson, W. A., *J. Sci. Instrum.*, **40**, 568 (1963).

<sup>2</sup> Boys, C. V., *Nature*, **47**, 440 (1893).

<sup>3</sup> Benioff, H., Ewing, M., and Press, F., *Proc. U.S. Nat. Acad. Sci.*, **5**, 37, 600 (1951).

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